TELEPHONES AND OTHER APPLICATIONS OF ELECTRICITY

IN a recent number we gave some account of the telephone of Mr. Elisha Gray; in the present article we propose to refer to another form of this instrument, as also to the so-called electric telegraph without conductors, and its relation to electric tuning-forks. For our information, as well as for the illustrations, we are indebted to papers by M. Ch. Bontemps, in our French contemporary, *La Nature.* To begin with the last-mentioned application of electricity.

For this new process of telegraphy it is claimed that we may communicate with any person at any distance without having taken the precaution of previously establishing a continuous wire between the two stations.

M. Bourbouze, in 1870, in continuation of previous experiments, attempted at Paris to utilise the Seine as a conductor between two stations, the Jena and Austerlitz bridges. This attempt, if successful, would then have been of great practical value, as it would have enabled besieged Paris to communicate with the outside world. An electric pile placed on the Jena bridge sent alternative currents to Austerlitz bridge. These currents were received in a galvanometer invented by M. Bourbouze, and read by the oscillation of the needle to right or left. The experiment appeared successful; the elements of a language were proved in this attempt. There was no opportunity, however, of further testing its utility; a mission was organised for the purpose of establishing a station beyond the lines, but ere it could be carried out the armistice rendered further experiment unnecessary. M. Bourbouze has, however, again taken the matter up; but it is necessary to be on our guard against cherishing hopes which seem premature.

M. de Parville points out very well the objection which common sense suggests. "Suppose," he says, "that we should all wish to speak by this means from one end of a city to the other. Each possesses his talking-needle and his pile. Each needle goes marching ceaselessly to right, to left, obeying everybody at once. It will speak for all correspondents at the same time. Messages will get entangled and completely mixed up. Here is a new Tower of Babel. We won't be able any longer to understand each other. The electric wire of the ordinary telegraph, on the contrary, serves as a track of union, and shuts the door to indiscretions. Thus, *yes*, we may communicate to a distance without a wire; *no*, we should not be able to supply by this new system, since we should find ourselves in the condition of a crowd speaking at once miscellaneously, without being able to make itself understood. For the new system to become applicable, it would be necessary to find the means of giving to each current an individuality which would enable a correspondent to recognise it among the thousands of currents which may circulate at one time. We have no right to doubt the future, and we may hope that some day such a means will be discovered."

In this connection let us explain the remarkable work of a Danish engineer, M. Paul Lacour. How can we give to each current an individuality which will enable us to recognise it?

When we consider the most common acoustical phenomena, for example, the transmission of an air played by an orchestra, which is perceived by all the audience at considerable distances from the executants, we have some difficulty in analysing this effect. Physics tells us that the sounds produced by each instrument have their proper tone and their distinct measure; in other words, the notes which come from a violin, a flute, a trombone, correspond to different vibrations transmitted by the atmosphere and characteristic of each note. Besides, the rhythm in the succession of the notes, which makes the measure in music, produces the cadence, constituting with the tonality and the timbre of the instruments the general effect of the air which impresses itself upon us. The transmission is so precise that an ear detects in this assembly of performers a mistimed note, anything out of tune in the midst of the harmony of the air. In our exposition it is the mistimed note which will serve us as a landmark.

Suppose a series of three tuning-forks vibrating continuously and producing—the first, 100 vibrations per second; the second, 300; and the third, 500. It is easy to conceive that each of these tuning-forks may interrupt and establish an electric current with intermissions regulated by the number of its vibrations. If we have three tuning-forks identical with the three former, we can conceive each group to be placed at the extremity of an electric line serving as a medium of connection. We shall see reproduced the phenomenon of the musical air transmitted to a distance: the three transmitting tuning-forks act respectively on the three receiving forks by means of the medium which connects them.

Let us admit, meantime, that by an effort of the will we may either set a-going or stop any one of these tuning-forks in accordance with a cadence that will not necessarily coincide with its regular action, we shall find at the other extremity in the symmetry of the perturbed instrument, the same discordant manifestations. The mistimed note will be as faithfully transmitted as the harmonic vibrations. The bearing of a practical realisation of this conception will be easily understood; it opens the way to the indefinite multiplication of diverse transmission by the same conductor; it is also the germ of a solution of transmission by multiple conductors, with the power of individualising each current.

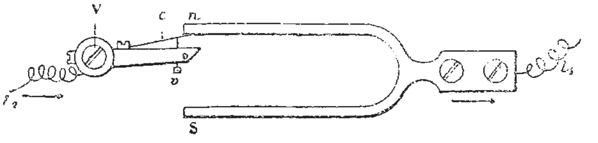

FIG. 1.—Transmitting tuning-fork.

What is necessary to the fulfilment of this condition? 1. It is necessary to construct tuning-forks whose movement is maintained by an electric current; this problem has been solved. 2. It is necessary that these forks emit currents whose phases correspond exactly with their movement, a problem which has also been solved. 3. Finally, we must be able, in a very small interval of time, say one second, to arrest and put in action a great number of times (100 at least) each of these forks. This last point is the only one which presents any difficulty. We see that this difficulty is only a problem of construction; it is necessary to operate with very small masses in order easily to overcome inertia. The success of M. Marcel Deprez authorises us in thinking that the third condition may be realised.

We shall conclude this part of the subject by a reference to figures. We shall show how a diapason vibrating continuously can send currents of the same intermittence along an electric line. Fig. 1 represents the necessary apparatus. The arm n of the tuning-fork encounters alternately the platinum of the tongue c, whose opening is regulated by the screw v. A current entering by l_2 is closed every time that the extremity n touches the slip c, and is opened when the vibration of the tuning-fork is away from the extremity n; there is only required for this that by the wire l_1 issuing by the exterior conductor, the line, there be propagated a series of electric undulations reproduced exactly in the material vibrations of the arm of the tuning-fork.

We have, however, to show how we can determine and mark the character of an intermittent current arriving by the telegraphic wire. Fig. 2 represents the arrangement

of the intermediate station traversed by the line L L; A, B, C are three tuning-forks similar to those of the transmitting station. The fork B, for example, which is in unison with the current, will enter into vibration while the others remain mute. This fork B will then touch the platinum tongue (shown in Fig. 3), and there will be established in the circuit $b\,b'$ a local current of the pile U whose poles are applied respectively to a, b, c, and to a', b', c'. This local current will be intermittent in pro-

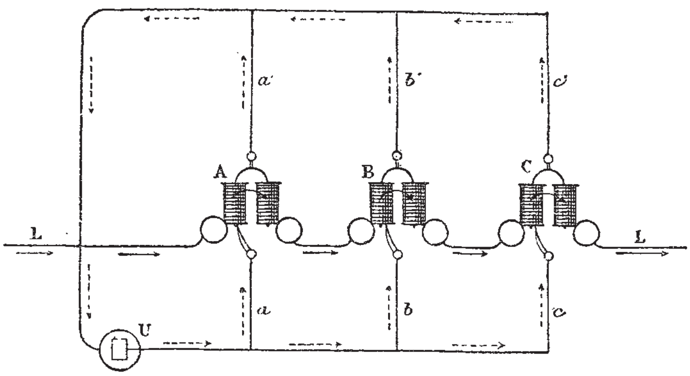

FIG. 2.—Intermediate station.

portion to the time of the tuning-fork, but on account of the rapidity of the pulsations it will show itself in many cases as a constant current either by effecting chemical decomposition, by causing the deviation of an electric needle, or by energising an electro-magnet.

Fig. 3 shows the arrangement which has been established to produce interruptions for correspondence by means of the regulated vibrations of the tuning-fork. The

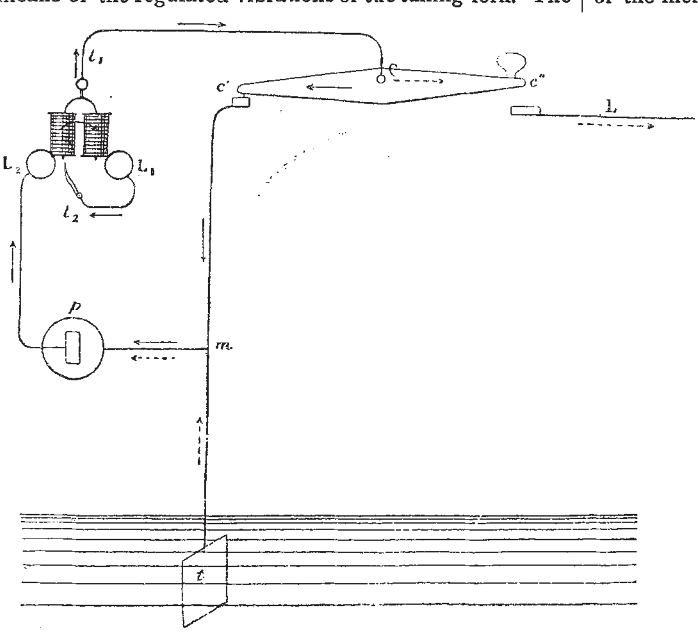

FIG. 3.—Manipulator.

manipulator C, which can oscillate around a central axis, rests sometimes on c' sometimes on c''. Acording as the lever C is supported on c' or c'', it closes the circuit of the intermittent current emitted by the tuning-fork, either by the earth of the transmitting station or by the earth of the receiving station, after traversing the guiding wire.

It would seem, then, that the only objection to the practical realisation of the system of multiplying correspondence in one or more directions, lies in the greater or less facility with which a tuning-fork can be stopped and put in action; it is a question of mass, and cunning fingers will certainly some day devise for us apparatus sufficiently small to realise this desideratum.

With regard to the telephone, an instrument allied in some respects to the apparatus above referred to, we shall specially refer here to that which bears the name of M. Reuss. For an account of Mr. Gray's instrument, see vol. xiv., p. 30. The arrangement adopted by M. Reuss will be seen in Figs. 4 and 5—the former representing the transmitting apparatus, and the latter the receiving apparatus.

At the station at which the musical air is played (Fig. 4) a wide tube T issuing from a box K receives the vibrations of air produced by the instrument. The purpose of the box is to collect and strengthen the sound. On the upper part is stretched a membrane *m*, which vibrates in unison with the impulses it receives. To transform the movements of this membrane into the harmonious emissions and interruptions of an electric current, it is sufficient to establish a series of connections easy to conceive.

Suppose that a pile, one of whose poles is the earth, is attached by the other electrode to a handle marked 2 in Fig. 4; from this a metallic conductor formed by a thin plate of copper *i* and ending in a disc of platinum *o*, leads the current in front of a point borne by the lever *a b c*. Every time that the membrane *m* is raised, the point touching the disc, the current will be established; on the other hand it will be broken when the membrane returns to its normal state. The box K is represented cut away at the upper part in order to show the arrangement of the membrane and the electric communication which repeats the vibrations. In order to transmit to any distance 100, 200, 500 kilometres the electric current, it is necessary that a line should issue from the knob 1 (Fig. 1), and be attached to knob 3 (Fig. 2, which represents the receiving apparatus). The latter is formed by an iron rod *d d*, around which is rolled insulated copper wire, one extremity of which ends at the knob 3, and the other in the earth by the screw 4, for the purpose of completing the circuit of the pile of the issuing station. The rod, *d d*, is of the size of a knitting-needle; the coil, *g*, formed by the combined wire and rod, is supported on a box, B, having very thin sides; above is the lid, D. The object of the whole arrangement is to strengthen the vibrations which are produced by the successive interruptions of the current across the rod, *d d*.

What is noteworthy in this system is that the vibrations of the rod, *d d*, are exactly synchronous with those of the membrane, *m*, and consequently with those of the instrument, the air from which has been played in the tub, T. Not only is the measure indicated, but the tonality as well, the two elements which make up the melody, height of sound, and interval of notes, all is reproduced automatically without possibility of error.

To complete the description, we must add that there is on Fig. 1, a lever, *ts*, and an electro-magnet, E E, the ordinary appendages of a Morse telegraph. Also on Fig. 2 is seen the manipulatory lever; there is also a receiver, not represented in the figure.

In order to appreciate the full value of the telephone, it is necessary to examine the form given to the box, K; the best arrangement hitherto discovered consists in bending the sides so as to amplify the effect on the mem-

brane by successive reflections. The power of the receiver is also increased by the introduction into the coil of several rods of iron; the sound originally somewhat snuffling, thus acquires a more agreeable tone.

M. Reuss calls the attention of physicists to the experiment; we think, with him, that there is here the germ of notable improvements to be made on the electric telegraph.

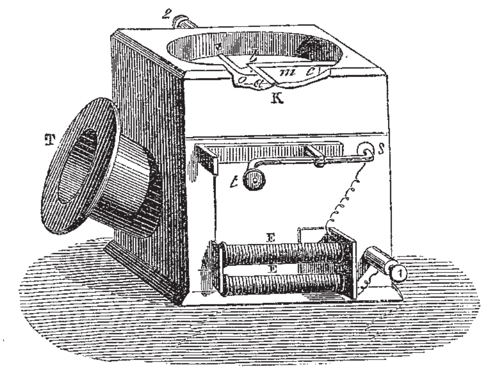

FIG. 4.—Sending apparatus.—K, box to collect the vibrations; *m*, caoutchouc membrane closing the box; *o*, platinum disc fixed to the membrane; *a b c*, movable lever, supported by the point on the membrane; *t s*, manipulating keys for correspondence; E E, receiving electro-magnet for correspondence; 2-1, screws to attach the communicating wires to the pile and with the line.

We do not, however, believe that in its present state, the invention is so complete that we can, at a distance, repeat on one or more pianos the air played by a similar instrument at the point of departure. There is a possibility here, we must admit, of a curious use of electricity. When we are going to have a dancing-party, there will

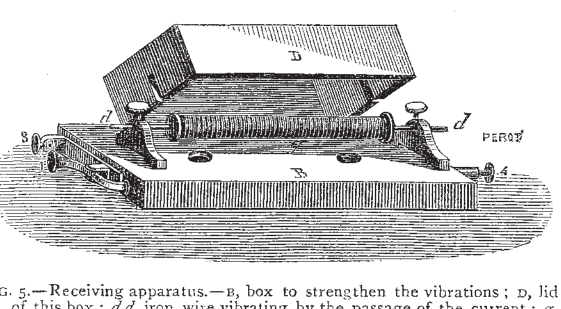

FIG. 5.—Receiving apparatus.—B, box to strengthen the vibrations; D, lid of this box; *d d*, iron wire vibrating by the passage of the current; *g*, coil through which the current passes; *t′ s′*, manipulating key for correspondence; 1, 2, 3, screws to attach the communicating wires to the pile and to the line.

be no need to provide a musician. By paying a subscription to some enterprising individual, who will, no doubt, come forward to work this vein, we can have from him, a waltz, a quadrille, or a galop, just as we may desire. Simply turn a bell-handle, as we do the cock of a water or gas-pipe, and we shall be supplied with what we want. Perhaps our children may find the thing simple enough.

INTERNATIONAL CONGRESS OF AMERICANISTS.

LAST July there met in the city of Nancy a congress of a somewhat novel kind (NATURE, vol. xii. p. 319) which, at the time, did not attract very much attention, but which, during its four days' sitting, did a considerable amount of work of varied value. This was the International Congress of Americanists, organised by a society recently formed in France under the designation "La Société Americaine de France." The society itself appears to be French, though the congresses are intended to be international in their character, and among those who were members of the last congress (though not necessarily present) were many eminent men belonging to all parts of the world. Among English names we notice those of Dr. Birch, Mr. Charles Darwin, Mr. Franks, Sir John Lubbock, Mr. R. H. Major, Prof. Max Müller, Sir Henry Rawlinson, Sir Charles Trevelyan, Mr. Trübner, and others. Delegates from various countries were present at the congress, and although most of the papers were by Frenchmen, still a fair proportion were by foreigners, chiefly Americans and Scandinavians. Two thick octavo volumes[1] contain the proceedings of the congress.

The object of this French society in holding these congresses is to contribute to the progress of ethnographical, linguistic, and historical studies relative to the two Americas, especially for the times anterior to Christopher Columbus, and to bring into connection with each other persons who are interested in these studies. The subscription is only twelve francs, and the council is composed of a certain proportion of French and of foreign members. The president of the Nancy congress was the Baron de Dumast, but at each of the four *séances* for the reading of papers he very gracefully called to the chair a distinguished foreign member to preside over the day's proceedings. During the congress an interesting exhibition of objects relating to American ethnography and antiquities was held.

The subjects with which the congress dealt were divided into three sections—History, Ethnography, and Linguistics and Palæography, though, as might be surmised, many of the papers bore on all these subjects. Though the subjects were thus divided, the congress met as one body each day.

Such an international congress as this, it will be admitted, might do great service to science. The ethnography and prehistoric archæology of America are of the highest importance; they are a prime factor in the great problem of the world's ethnography. If, then, an international American congress were based on well-defined principles, and if its work were conducted in accordance with the universally recognised rules of scientific method, it might give a powerful impulse to the progress of American ethnology in particular, and to ethnography in general. We shall briefly endeavour to give the reader an idea of the value of the contents of the two volumes before us.

Among the first papers is one of considerable length, by M. E. Beauvois, the purpose of which is to prove that the "Irland it mikla," or "Hvitramannaland" of the early Icelandic chroniclers was a colony founded by Irish missionaries, apparently near the mouth of the St. Lawrence, long before even the Norseman knew anything of America. One cannot but admire the learning, ingenuity, and enthusiasm of M. Beauvois, but the verdict must be the Scotch one of "not proven," with a note that it was scarcely worth while calling together an international congress to listen to a paper of this kind.

This may be regarded as a type, and rather a favourable one, of a large number of the papers read at the Nancy congress, papers whose object was to show the intimate connection which in prehistoric times existed between the peoples of the Old World and those of the New. A paper by Prof. Paul Gaffarel of Dijon, for example, had for its object to show the great probability that the Phœnicians had found their way across the Atlantic to America, North and South, and that in various ways they left traces of their presence behind. This is a somewhat more sober paper than that of M. Beauvois, still the verdict must be essentially the same.

Of course the questions of Buddhists in America and of "Fu-Sang" got their share of attention, with the usual

[1] Congrès International des Américanistes. Compte-Rendu de la Première Session, Nancy, 1875. (Paris, Maisonneuve et Cie.)